PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Olvi L. Mangasarian; Glenn M. Fung	Confirmation No.	5513
Serial No.:	10/650,121		
Filed:	August 28, 2003	Customer No.:	28863
Examiner:	Mai T. Tran	Group Art Unit:	2129
Docket No.:	1061-001US01		
Title:	INPUT FEATURE AND KERNEL SELECTION FOR SUPPORT VECTOR MACHINE CLASSIFICATION		

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By: Nancy J. Burr
Name: Nancy J. Burr

MAIL STOP APPEAL BRIEF-PATENTS
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Alexandria, VA 22313-1450

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BRIEF ON APPEAL

Mail Stop: Appeal Brief-Patents
Commissioner for Patents
Alexandria, VA 22313-1450

Sir:

This is an Appeal from the final Office Action mailed on October 20, 2006, finally rejecting claims 1-57. The Notice of Appeal was filed on January 19, 2007.

Please charge Deposit Account Number 50-1778 in the amount of $250.00 to cover the required small entity fee for filing this Brief On Appeal. Any deficiencies or overpayment can also be charged or credited to Shumaker & Sieffert, P.A., Deposit Account Number 50-1778.

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REAL PARTY IN INTEREST

The Real Party in Interest is Wisconsin Alumni Research Foundation of Madison, Wisconsin.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences for the above-referenced patent application.

STATUS OF CLAIMS

Claims 1-57 are pending and are the subject of this Appeal. The claims are set forth in Appendix A (attached). Claims 1-47, 49, 50, 52, 53, and 55-57 stand rejected under 35 U.S.C. § 101 as not being directed to statutory subject matter. Claims 1-47, 49, 50, 52, 53, and 55-57 also stand rejected under 35 U.S.C. § 112, first paragraph as failing to disclose how to practice an allegedly undisclosed practical application. Claims 1-57 stand rejected under 35 U.S.C. § 102(b) as being anticipated by "Finite Newton Method for Lagrangian Support Vector Machine Classification," by Glenn Fung et al., Data Mining Institute Report, 02-01, February 2002 (hereinafter referred to as "Fung").

STATUS OF AMENDMENTS

Appellant has not filed any amendment in response to the Final Office Action.

SUMMARY OF CLAIMED SUBJECT MATTER

In general, all pending claims relate to support vector machine (SVM) classifiers, and more particularly selection of an input set for an SVM classifier to carry out data classification.[1] Moreover, some of the claims are further directed to classifying data via the SVM classifier using the selected input set.[2] To enhance performance of the SVM classifier, it is desirable to

[1] Appellant's specification, ¶ [0004].
[2] Id. at ¶ [0019].

make the input set for the SVM classifier as small as possible.[3] Applications such as fraud detection, credit evaluation, gene expression, and medical diagnosis or prognosis, for example, may present an input space with thousands, or even millions, of data points.[4] The invention as claimed is directed to an input feature or kernel selection technique for SVM classification that results in a reduced set of input features or kernel functions, and classification of the input data using the reduced set of input features or kernel functions.[5]

A data classification system may include an input module that generates an input data set, e.g., feature-kernel selection module 16 of FIGS. 1 and 2, and an SVM classifier that classifies input data based on the input data set, e.g., SVM classifier 18 of FIG. 1.[6] The input module defines a linear programming formulation of the SVM classifier.[7] The input module solves an exterior penalty function of a dual of the linear programming formulation to produce a solution to the SVM classifier.[8] Based on the solution of the exterior penalty function, the input module processes a set of input data to suppress redundant features or kernels, and thereby generates a set of reduced feature or kernel coefficients for use by the SVM classifier.[9] Thus, the input module may be effective in suppressing input features for linear SVM classifiers and suppressing kernel functions for nonlinear SVM classifiers to generate a reduced set of input features or kernel functions in the case of a nonlinear classifier.[10]

The SVM classifier applies the input features (or kernel functions) produced by the input module to classify the input data set into at least two sets of data.[11] An input module that utilizes the techniques of the claimed invention enables formulation of an SVM classifier that is capable of handling classification problems in very high dimensional spaces.[12] The ability to suppress less useful data and select a reduced set of meaningful input data can greatly enhance the performance of the SVM classifier, in terms of computational resources, speed, and accuracy.[13]

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[3] Id. at ¶ [0003].
[4] Id.
[5] Id. at ¶¶ [0004] and [0019].
[6] Id. at ¶¶ [0018]-[0019].
[7] Id. at ¶ [0018].
[8] Id.
[9] Id. at ¶ [0024].
[10] Id. at ¶ [0020].
[11] Id. at ¶ [0022].
[12] Id. at ¶ [0023].
[13] Id. at ¶ [0009].

Independent claim 1 defines a method comprising defining a linear programming formulation of a support vector machine classifier,[14] solving an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier,[15] and selecting an input set for the support vector machine classifier based on the solution.[16]

Independent claim 16 defines a classification system comprising a processor[17] that applies a linear programming formulation of a support vector machine classifier to classify data based on an input set and an input module[18] that generates the input set based on a solution of an exterior penalty function of a dual of the linear programming formulation.

Independent claim 31 defines a computer-readable medium[19] comprising instructions to cause a processor to define a linear programming formulation of a support vector machine classifier,[20] solve an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier,[21] and select an input set for the support vector machine classifier based on the solution[22].

Independent claim 55 defines a support vector machine classification system comprising a data storage medium[23] storing input data for classification, a support vector machine classifier[24] that classifies the input data into a first set of data and a second set of data based on a set of input features and a selection module[25] that produces a reduced set of input features for the support vector machine classifier based on a minimization of an exterior penalty function of a dual of a linear programming formulation of the linear support vector machine classifier for a finite value of a penalty parameter.[26]

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[14] See, e.g., Id. at ¶¶ [0018] and [0025].
[15] Id. at ¶¶ [0024]-[0025].
[16] Id. at ¶¶ [0018] and [0025].
[17] Id. at ¶¶ [0017]-[0022] and FIG. 1, reference numeral 14.
[18] Id. at ¶¶ [0007] and [0020] and FIG. 1, reference numeral 16.
[19] Id. at ¶¶ [0017] and [0073].
[20] Id. at ¶¶ [0017]-[0018].
[21] Id.
[22] Id.
[23] Id. at ¶ [0017]
[24] Id. at ¶¶ [0017]-[0022] and FIG. 1, reference numeral 18.
[25] Id. at ¶¶ [0017]-[0022] and FIG. 1, reference numeral 16.
[26] Id. at ¶ [0021].

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-47, 49, 50, 52, 53, and 55-57 stand rejected under 35 U.S.C. § 101 as not being directed to statutory subject matter. Claims 1-47, 49, 50, 52, 53, and 55-57 also stand rejected under 35 U.S.C. § 112, first paragraph as failing to disclose how to practice an allegedly undisclosed practical application. Claims 1-57 stand rejected under 35 U.S.C. § 102(b) as being anticipated by "Finite Newton Method for Lagrangian Support Vector Machine Classification," by Glenn Fung et al. (hereinafter referred to as "Fung").

ARGUMENT

Claim Rejection Under 35 U.S.C. § 101

In the Office Action, the Examiner rejected claims 1-47, 49, 50, and 52-57 under 35 U.S.C. § 101 as being directed to non-statutory subject matter. Appellant respectfully requests reversal of this rejection. Appellant's claims define statutory subject matter for purposes of 35 U.S.C. § 101. As will be described in more detail below, the Examiner's analysis in support of the rejection under section 101 relies on both legal and factual errors.

Section 101 states that:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.[27]

The Supreme Court and the Court of Appeals for the Federal Circuit ("Federal Circuit") have interpreted section 101 to provide a very broad definition of what subject matter is patentable. The Supreme Court in *Diamond v. Chakrabarty* held that Congress chose the expansive language of 35 U.S.C. § 101 so as to include "anything under the sun that is made by man."[28] The Supreme Court has limited their broad and sweeping interpretation of section 101 by indicating that not every discovery is embraced within section 101.[29] In particular, the Supreme Court specifically excluded patent protection for discoveries that are "laws of nature, physical

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[27] 35 U.S.C. § 101.
[28] *Diamond v. Chakrabarty*, 447 U.S. 303, 308-09 (1980).
[29] *Diamond v. Diehr*, 450 U.S. 175, 185 (1981).

phenomena and abstract ideas."[30] Moreover, the Supreme Court also excluded from patent protection claims that attempt to patent every substantial practical application of an idea, law of nature or natural phenomena because such a patent "in practical effect [is] a patent on the [idea, law of nature or natural phenomena] itself."[31] This concept is known as preemption.

Although the Supreme Court limited their broad and sweeping interpretation that anything under the sun made by man is patentable subject matter, patent protection is not excluded for application of an abstract idea, such as a mathematical algorithm, to a new and useful end.[32] For claims including such excluded subject matter to be eligible, the claim must be for a practical application of the abstract idea, law of nature, or natural phenomenon.[33] The Federal Circuit, following the Supreme Court's guidance in *Diehr*, concluded that "[u]npatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not '**useful**.'... [T]o be patentable an algorithm must be applied in a '**useful**' way."[34] Thus, the court in *State Street* indicated that a mathematical algorithm is not patentable until it is reduced to some type of practical application, i.e., "a useful, concrete and tangible result."[35]

As noted in *AT&T Corp. v. Excel Communications Inc.*, the *State Street* formulation, that a mathematical algorithm may be an integral part of patentable subject matter such as a machine or process if the claimed invention as a whole is applied in a **"useful"** manner, follows the approach taken by this court en banc in *In re Alappat*.[36] Thus, the *Alappat* inquiry simply requires an examination of the contested claims to see if the claimed subject matter as a whole is a disembodied mathematical concept representing nothing more than a "law of nature" or an "abstract idea," or if the mathematical concept has been reduced to some practical application

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[30] Id.; see, e.g., *Gottschalk v. Benson*, 409 U.S. 63 (1972) (finding a claim directed to an algorithm for converting binary code decimal numbers to equivalent pure binary numbers unpatentable); *Parker v. Flook*, 437 U.S. 584 (1978) (finding a claimed method drawn to computing an alarm limit using an algorithm unpatentable).

[31] *Benson* at 71-72; Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility ("Interim Guidelines"), pg. 14.

[32] *Diehr* at 188-89; *Mackay Radio & Telegraph Co. v. Radio Corp. of America*, 306 U.S. 86, 94 (1939) (stating that "[w]hile a scientific truth, or the mathematical expression of it, is not a patentable invention, a novel and useful structure created with the aid and knowledge of scientific truth may be.").

[33] *Diehr* at 209 (stating that "application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection."); *In re Alappat*, 33 F.3d 1526, 1543 (Fed. Cir. 1994).

[34] *State Street Bank & Trust Co. v. Signature Financial Group*, 149 F.3d 1368, 1373 (Fed. Cir. 1998) (emphasis added).

[35] Id.

[36] *AT&T Corp. v. Excel Communications Inc.*, 172 F.3d 1352, 1357 (Fed. Cir. 1999) (emphasis added).

rendering it "**useful**."[37]

The United States Patent and Trademark Office (USPTO) sets forth its understanding of the current case law in its Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility ("Interim Guidelines"). The USPTO's interpretation of the current case law follows that described above. In particular, the Interim Guidelines state that to be patentable the claimed invention as a whole must have a practical application.[38] Practical application may be shown by illustrating that the claimed invention either (1) physically transforms an article or (2) provides a practical application that produces a useful, concrete and tangible result.[39] The purpose of this requirement is to limit patent protection to inventions that possess a certain level of "real-world" value, i.e., is useful, as opposed to subject matter that represents nothing more than an idea or concept, or is simply a starting point for future investigation or research.[40]

Appellant's arguments are set forth below. In the following arguments, any claim argued separately is placed under a subheading identifying the claim by number. Claims argued as a group are placed under common subheadings, identifying such claims by number.

Claims 1-6, 10, 11, 31-36, 40, and 41

Claim 1 recites a method comprising defining a linear programming formulation of a support vector machine classifier, solving an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier, and selecting an input set for the support vector machine classifier based on the solution. Claim 31 recites a computer-readable medium comprising instructions that cause a processor to carry out the method.

Appellant and the Examiner appear to agree that the application of claims 1-6, 10, 11, 31-36, 40, and 41 is the selection of an input set for an SVM classifier.[41] What Appellant and the

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[37] Id.
[38] Interim Guidelines, pg. 4; *In re Alappat* at 1543.
[39] Interim Guidelines, pgs. 4 and 20.
[40] Id. at 4; *Arrhythmia Research Technology, Inc. v. Corazonix Corp.*, 958 F.2d 1053, 1057 (Fed. Cir. 1992) (quoting *In re Bradley*, 600 F.2d 807, 811-112 (CCPA 1979) *aff'd by an equally divided court, sub nom. Diamond v. Bradley,* 450 U.S. 381 (1981).
[41] Final Office Action, pg. 8.

Examiner disagree on, however, is whether Appellant must specify selection of a particular type of input data for the SVM classifier in order for this application to be considered "practical." Notably, the Examiner has withdrawn the rejection under section 101 for claim 48, 51 and 54, each of which is directed to selecting and classifying data relating to absolute call measurements for multiple myeloma.[42] Appellant agrees that selecting and classifying data relating to absolute call measurements for multiple myeloma presents a practical application. However, Appellant disagrees with the Examiner's assertion that, to satisfy section 101, the claims must specify a specific type of data that is selected as input data for the SVM classifier.

In support of the rejection under section 101, the Examiner determined that "[i]n their broadest reasonable interpretation, the claims can be interpreted to be a computer program per se that merely selects [an] unspecified, abstract, arbitrary input data set for the SVM classifier to carry out a mathematical algorithm."[43] Appellant disagrees. As will be described in more detail below, the Examiner's analysis in support of the rejection under section 101 relies on both legal and factual errors.

In terms of legal error, the Examiner has continually focused on the "real world" nature of the data selected or classified in accordance with Appellant's claims.[44] On the contrary, the Examiner should have considered the practical application presented by support vector machine classification *per se*, without regard to a particular data type. In other words, the practical application presented by the claims is data classification without regard to data type, just as fluid handling represents a practical application without regard to a particular type of fluid. Data classification is a specific practical application having a real-world result, i.e., classification of data. The claims do not recite mere abstract number crunching. On the contrary, the claimed invention is very specifically limited to the practical context of an SVM classifier.

In her analysis, the Examiner repeatedly stated that the claims "merely select [an] unspecified, abstract, arbitrary input data set for a [SVM] classifier," and therefore do not provide a useful, concrete and tangible result. Appellant respectfully submits that the Examiner has elevated the requirement of practical application above the level required by law. Neither the case law nor the USPTO's current understanding of the case law, as set forth in the "Interim

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[42] Id. at pg. 16
[43] Id. at pg. 9.
[44] See Id. at pg. 11; *Arrhythmia Research Technology* at 1057.

Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility" (hereinafter "Interim Guidelines"), require the claims to recite the particular type of data that is utilized in the claimed invention provided the claimed invention as a whole is directed to a practical application.

The case law as set forth by the Supreme Court and the Federal Circuit requires that the claimed invention as a whole must be for a practical application, which can be illustrated if the invention produces a "useful, concrete and tangible result."[45] The purpose of this requirement is to limit patent protection to inventions that possess a certain level of "real world" value, i.e., is useful, as opposed to subject matter that represents nothing more than an idea or concept.[46] More specifically, of particular importance is "what the [claimed invention] is doing."[47] Appellant's claims 1-6, 10, 11, 31-36, 40, and 41 clearly set forth a "useful, concrete and tangible result" that describes exactly what the claimed invention is doing, i.e., selection of an input set for an SVM classifier based on the solution to an exterior penalty function of a dual of a linear programming formulation. Such a result is clearly a practical application in that it is useful, real-world result.[48]

The subject matter of the claimed invention clearly provides a useful result, i.e., selection of an input set for the SVM classifier. In particular, the claimed invention produces a reduced input set for use by a SVM classifier using a solution to an exterior penalty function of a dual of a linear programming formulation.[49] As described in Appellant's specification, typical input sets for SVM classifiers may present thousands, or even millions, of data points, and each data point may consist of hundreds of components.[50] The claimed invention permits suppression of the input set components to substantially enhance the performance of an SVM classifier in terms of

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[45] *State Street Bank & Trust Co. v. Signature Financial Group Inc.*, 149 F. 3d 1368, 1373-74 (Fed. Cir. 1998).
[46] Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility, pg. 4 (citing *Brenner v. Manson*, 383 U.S. 519, 528-36, 148 USPQ 689, 693-96 (1966)); *In re Fisher*, 421 F.3d 1365, 76 USPQ2d 1225 (Fed. Cir. 2005); and *In re Ziegler*, 992 F.2d 1197, 1200-03, 26 USPQ2d 1600, 1603-06 (Fed. Cir. 1993)); *Arrhythmia Research Technology* at 1057.
[47] Id. at pg. 5.
[48] *AT&T*, 172 F.3d at 1357.
[49] *Arrhythmia Research Technology*, 958 F.2d at 1059 (finding method for analyzing electrocardiogram signals to be a useful result); *State Street Bank*, 149 F.3d at 1373 (finding transformation of data, representing discrete dollar amounts through a series of mathematical equations to calculate a final share price to be a useful result).
[50] Appellant's specification, ¶ [0003].

computational resources, speed and accuracy.[51] Clearly, selecting an input set that results in enhanced performance of the SVM classifier is a useful result.[52]

The result provided by the claimed invention is also concrete within the meaning of section 101. In particular, the data classification results are concrete in the sense they provide a repeatable, predictable result in selecting the input set for the SVM classifier.[53] In the Final Office Action, the Examiner stated that it is unclear "how the result can be repeatable and predictable if the input data is unspecified, abstract and arbitrary." The point of repeatability is not that the same data set is selected over and over again, which would be meaningless. Rather, a concrete result requires that the claimed invention operate in a predictable, repeatable manner to deliver consistent results, without regard to the particular type of input data.[54] The concrete result, per the claims, is an input data set that is selected based on the solution of an exterior penalty function of the dual of the linear programming formulation. The claimed method is repeatable in that it can readily select input data sets based on the solution of the exterior penalty function of the dual of the linear programming formulation. The Examiner has made no assertion that the claimed invention would not work on a consistent, repeatable basis, nor that the results of the claimed invention would be unpredictable.[55] Accordingly, there should be no question that the claimed invention provides a concrete result.

Finally, the claimed invention also provides a tangible result. Neither section 101 nor the case law require that, to be tangible, a claim be tied to a particular machine or apparatus or operate to change articles or materials to a different state or thing.[56] On the contrary, the result must be tangible in the sense that the claimed invention provides a practical application that has real-world value.[57] As described above, the tangible result provided by the claimed invention is

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[51] Id. at ¶ [0010]
[52] *AT&T*, 172 F.3d at 1357.
[53] *In re Swartz*, 232 F.3d 862, 864 (Fed. Cir. 2000) (stating that where asserted result produced by the claimed invention is "irreproducible" claim should be rejected under section 101); Interim Guidelines, pg. 22.
[54] Id.
[55] Id.
[56] *AT&T Corp. v. Excel Communications, Inc.*, 50 USPQ2d 1447 (Fed. Cir. 1999).
[57] Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility, pg. 21; Benson 409 U.S. at 71-72 (invention ineligible because had "no substantial practical application."); *Arrhythmia Research Technology* at 1057 (stating that of importance is the significance of the data and their manipulation in the real world, i.e., *what* the computer is doing); *State Street,* 149 F.3d at 1373 (stating that unpatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not 'useful.'... [T]o be patentable an algorithm must be applied in a 'useful' way.).

the selection of an input set for an SVM classifier based on a solution to an exterior penalty function of a dual of a linear programming formulation. Thus, the claimed invention produces a reduced input set for use by a SVM classifier in classifying data, which one skilled in the art would determine provides "real-world" value (e.g., an enhanced performance classifier).[58] This result is tangible in the sense that it provides an input data set for use in data classification. Data classification is a well-established technology used in thousands of businesses, clinics and research institutions on a daily basis to classify data into different categories. In some instances, data classification may be associated with the more familiar term "data mining." Data classification, like data encryption, data coding, and data compression, represents a practical application that provides tremendous real-world value.

Nowhere in either the case law or the USPTO's current understanding of the case law as set forth in the Interim Guidelines is there a requirement that a claimed invention must specify the specific type of data utilized in the claimed invention in order to support a practical application for purposes of section 101. It is true that a particular type of data has been found to be probative evidence of a practical application.[59] However, a requirement that the claims recite a particular type of data side-steps the basic question of statutory eligibility, i.e., what did Applicants invent? Such a requirement is not present in the law. Here, identification of the particular type of data classified by the SVM classifier is not necessary to support a practical application. Rather, the practical application of the claimed invention is the selection of input data for the SVM classifier regardless of the type of data to be classified, which is clearly useful in the real-world context.[60] Again, this is similar to an invention relating to data classification, data mining, data encryption, data encoding or data compression. In those cases, mathematical expressions are applied to classify, mine, encrypt, encode or compress data, without necessary regard to the particular nature of the data.

Numerous patents have issued with claims relating to data classification, some even in the context of SVM classifiers, without reciting the particular type of data that is being classified. With respect to those patents, the USPTO no doubt recognized the practical application inherent

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[58] *Arrhythmia Research Technology* at 1057.
[59] *Arrhythmia Research Technology*, 958 F.2d at 1059 (finding method for analyzing electrocardiogram signals patentable); *State Street Bank*, 149 F.3d at 1373 (finding transformation of data, representing discrete dollar amounts through a series of mathematical equations to calculate a final share price patentable).
[60] *AT&T*, 172 F.3d at 1357.

in the act of data classification. Appellant does not identify these previously issued patent applications to give them the weight of binding precedent. Although Appellant is entitled to expect administrative regularity, it is understood that USPTO action in one instance may not necessarily bind similar action in another instance. Instead, Appellant relies on the issued patents listed below as evidence of the proper application of the law by the USPTO, thus highlighting the errors in the current rejection.

In one example, U.S. Patent No. 7,020,642 (hereinafter "the '642 patent"), which issued less than a year ago, describes a system and method for preprocessing input data to a support vector machine (SVM). The claims of the '642 patent recite a method for processing input data prior to input to a support vector machine having multiple inputs, each of the inputs associated with a portion of the input data. The method comprises receiving and storing the input data, the input data associated with at least two of the inputs being on different time scales relative to each other; time merging the input data for the inputs such that all of the input data are reconciled to the same time scale; outputting the reconciled time merged data as reconciled data, the reconciled data comprising the input data to the support vector machine; providing the reconciled data as input data to the multiple inputs of the support vector machine; and the support vector machine generating output data in accordance with the reconciled data. Like Appellant's claims, the claims of the '642 patent do not specify a particular type of data that is preprocessed. Instead, the USPTO must have recognized that the practical application of the claimed invention does not depend on the type of data that is preprocessed, but rather the invention as a whole in terms of the result achieved. In each case, the data classification resulting from the input data provides tangible, real-world value.[61]

In another example, U.S. Patent No. 6,941,301 (hereinafter "the '301 patent") also describes a system and method for processing input data to a support vector machine (SVM). The claims of the '301 recite a method for processing input data prior to input to a support vector machine having multiple inputs, each of the inputs associated with a portion of the input data, wherein the input data include one or more outlier values, the method comprising: receiving and storing the input data wherein the input data comprise run-time data; analyzing said input data to determine said one or more outliers values; removing said one or more outlier values, thereby

[61] *Arrhythmia Research Technology* 958 F.2d at 1057.

generating corrected input data wherein said corrected input data comprise corrected run-time data; and outputting the corrected input data, said corrected input data comprising the input data to the support vector machine; wherein the support vector machine comprises a nonlinear model having a set of model parameters defining a representation of a system, wherein said model parameters of said support vector machine have been trained to represent said system, the method further comprising: inputting said corrected run-time data into the support vector machine to generate run-time output data, wherein said run-time output data comprise one or both of control parameters for said system and predictive output information for said system. As with Appellant's claims, the claims of the '301 patent do not specify a particular type of data that is preprocessed for input to the SVM classifier. Again, the USPTO must have recognized that the practical application of the claimed invention does not depend on the type of data that is preprocessed, but rather the real-world value of the invention as a whole.[62]

In yet another example, U.S. Patent No. 6,134,344 (hereinafter "the '344 patent") describes improving the efficiency of any machine that uses an algorithm that maps to a higher dimensional space in which a given set of vectors is used in a test phase. The '344 patent claims recite a method for using a support vector machine, the method comprising the steps of receiving input data signals, using the support vector machine operable on the input data signals for providing an output signal, wherein the support vector machine utilizes reduced set vectors, wherein the reduced set vectors were a priori determined during a training phase using an unconstrained optimization approach other than an eigenvalue computation used for homogeneous quadratic kernels wherein the training phase further comprises the steps of receiving elements of a training set, generating a set of support vectors, the number of support vectors being NS, selecting a number m of reduced set vectors, where $m \leq NS$, and generating the number m of reduced set vectors using the unconstrained optimization approach. Like Appellant's claims, the '344 patent is directed to methods of reducing the input data set of a SVM. Also like Appellant's claims, the '344 patent does not recite a particular type of input data to which the method is applied.

In a further example, U.S. Patent No. 6,925,618 (hereinafter "the '618 patent") has claims that recite a method comprising identifying a set of physical parameters of a set of physical

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[62] *Arrhythmia Research Technology* 958 F.2d at 1057.

measurements that define said extraction sub problem; selecting a set of training cases for said specific extraction sub problem, each of said training cases including an associated set of said physical measurements; solving said specific extraction sub problem for each of said training cases using said associated set of physical measurements as an input to an accurate physics based model to generate an associated output; and training a support vector machine using said associated set of physical measurements and associated output as training data. The claims of the '618 patent do not mention the specific type of data to which the method is applied. Although the claims do recite the input data comprises physical measurements, such a characterization does not provide the necessary specificity as required by the Examiner in the current rejection.

In yet another example, U.S. Patent No. 6,760,715 (hereinafter "the '715 patent") describes support vector machines that are used to extract useful information from vast quantities of biological data. The '715 patent claims recite a method for enhancing knowledge discovered from biological data using comprising: pre-processing a training data set to add meaning to each of a plurality of training data points; training each of a plurality of support vector machines using the pre-processed training data set, each support vector machine comprising a different kernel; pre-processing a test data set to add meaning to each of a plurality of test data points; testing each of the plurality of trained support vector machines using the preprocessed test data set; and in response to receiving each of the test outputs from each of the plurality of trained support vector machines, comparing each of the test outputs with each other to determine which if any of the test output is an optimal solution. Again, the only mention of the specific type of data is the generic descriptor biological data, which under the Examiner's analysis, would not provide the necessary specificity.

The examples above are just a few of the examples that are related to classification of data using SVM classifiers. A vast number of patents have been granted in similar fields that do not specify the particular type of data utilized in the invention, such as data classification without SVM classifiers, data mining, data encoding, data compression and the like. Although only a few patents, along with their related claims, are described below, there are hundreds if not thousands of similar patents that do not recite the particular type of data used in the claimed methods. Appellant wants to re-emphasize that the patent applications are not being relied upon

as precedent, but as evidence that the Examiner is not applying the law set forth in the cases as understood by both the Appellant and set forth in the Interim Guidelines.

U.S. Patent No. 7,180,433 (hereinafter "the '433 patent"), for example, recites a method for multi-byte data compression and decompression, comprising the steps of storing previously received data bytes of uncompressed data; comparing the stored previously received data bytes to currently received data bytes to determine whether at least one or more of the data bytes match at least one or more of the stored data bytes, generating addresses of matching stored data bytes, utilizing a tree module system for said storing, comparing, and generating addresses, utilizing said addresses and corresponding byte matches to create compressed data, and decompressing said compressed data. The claims of the '433 patent clearly do not recite the type of data that decompressed using the claimed method.

As another example, U.S. Patent No. 7,043,476 (hereinafter "the '476 patent"), recites a method of discovering information relating to a collection of input data, the method comprising the steps of obtaining the collection of input data, wherein the collection of input data comprises data items, discovering information relating to the collection of input data based on a computation of a mutual information measure in accordance with at least a portion of the data items, wherein expected values of the mutual information measure are expressed as linear combinations of an incomplete Riemann zeta function, and outputting at least a portion of results associated with the computation of the mutual information measure, wherein at least a portion of the results represent the discovered information relating to the collection of input data. Again the claims do not recite the type of data used in the claimed method.

In a further example, U.S. Patent No. 6,954,155 (hereinafter "the '155 patent"), recites a data compression method for executing encode commands for PackBits compression by a processor, comprising the steps of: receiving input data, generating compressed data by executing an encode command group specialized for the PackBits compression including at least one command, based on a data string of the input data, and outputting the compressed data, wherein, first processing to obtain an encode processing state of the PackBits compression and to control output of a control code based on the encode processing state, second processing to control whether or not output of the input data without any processing is to be performed, based on the encode processing state, and third processing to control the output of the control code

upon completion of the PackBits compression, are performed in accordance with the encode command group. Again the claims do not recite the type of data used in the claimed method.

In a further example, U.S. Patent No. 6,728,689 (hereinafter "the '689 patent"), recites a method for classifying data, comprising the steps of: classifying objects in a domain dataset using at least two adaptive learning algorithms, each of said adaptive learning algorithms employing a data classification model, each of said data classification models having a bias, modifying at least one of said biases based on a performance evaluation of said classifying step, evaluating a performance of one of said adaptive learning algorithms with another of said adaptive learning algorithms, and selecting one of said data classification models to classify said data. The claims in the '689 patent also fail to recite the specific type of data used in the claimed method.

In the Final Office Action, the Examiner stated that regardless of what a patent says, it cannot be read to permit anything outside the scope of what the law permits.[63] Appellant agrees. Yet, Appellant contends that the identified patents represent the proper application of the law by the USPTO, and highlight the errors in the current rejection. The current analysis represents a misinterpretation of the law and a misconception of the requirements for a practical application. As specified by the law, and evidenced by the identified patents, practical application is not a matter of application of the claimed invention to a specific type of data, but rather an outcome that has consequence in the real world.[64] In the present application, that outcome is generation of an input data set for SVM data classification, which provides a real-world result.

Selection of an input set for a SVM classifier is not an abstract idea per se, but instead has value in the real world. In view of the remarks above, Appellant respectfully requests withdrawal of the rejection under section 101.

Claims 7-9, 16-26, and 37-39

Independent claim 16 recites a classification system comprising a processor that applies a linear programming formulation of a support vector machine classifier to classify data based on an input set and an input module that generates the input set based on a solution of an exterior penalty function of a dual of the linear programming formulation. For the reasons discussed

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[63] Final Office Action, pg. 20.

[64] *Arrhythmia Research Technology* 958 F.2d at 1057; Interim Guidelines, pg. 4.

above with respect to claims 1 and 31, claim 16 has practical application in the "real-world" because it has a useful, concrete and tangible result, i.e., the selection of an input set for the support vector machine classifier. Moreover, claim 16 has an additional practical application in that the data is classified by applying the linear programming formulation of the SVM classifier based on the input set. Claims 7-9, 17-26, and 37-39 set forth similar requirements pertaining to the real-world result of SVM data classification.

Moreover, for the same reasons described above, Appellant is not required to specify the specific type of data utilized in the claimed invention. For at least these reasons, claims 7-9, 16-26, and 37-39 provide a real-world practical application and, therefore, Appellant respectfully requests withdrawal of the rejection of these claims under section 101.

Claims 12-15, 27-30, and 42-45

With reference to claim 12, for example, which are dependent on claim 1, the claim recites selecting an input set includes selecting a subset of input features from a larger set of input features that is substantially larger than the subset of input features. Claim 12 provides a more specific practical application of Appellant's claimed techniques. In particular, the practical application described in claim 12 is the reduction of the input features from a set of input features that is substantially larger than the subset of input features selected.

Again, it should be clear that this result is a practical application regardless of the particular type of data set that is reduced. The claimed invention provides real-world value whether the data set reduced is data relating to fraud detection, credit evaluation, gene expression, medical diagnosis, or medical prognosis. In any of these cases, Appellant's claims solve an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier and select a subset of the larger data set as an input set for the support vector machine classifier based on the solution. The selection of a reduced input set for the SVM classifier enhance the performance of the SVM classifier in terms of computational resources, speed, and accuracy. Claims 13-15, 28-30, and 43-45 set forth similar requirements pertaining to the real-world result of SVM data classification.

For these reasons in addition to the reasons discussed above with respect to claims 1 and 31, claim 12 has practical application in the "real-world." For at least these reasons, claims 12-

15, 27-30, and 42-45 provide a real-world practical application, and therefore, Appellant respectfully requests withdrawal of the rejection of these claims under section 101.

Claim 46, 47, 49, 50, 52 and 53

With reference to dependent claim 46, 49 and 52, the claims recite applying the support vector machine classifier to classify data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis. Moreover, with respect to claim 47, 50 and 53, the claims recite applying the support vector machine classifier to classify data relating to multiple myeloma. For at least the reasons discussed above with respect to claims 1, 16 and 31, the claims provide a practical application without the need to specify the nature of data.

Moreover, even if application to a particular type of data were necessary, dependent claims 46, 47, 49, 50, 52 and 53 recite application of the SVM classifier to classify specific types of data. In particular, claims 46, 49 and 52 recite application of the SVM classifier to data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis. Similarly, claims 47, 50 and 53 recite applications of a support vector machine classifier to classify data relating to multiple myeloma. Clearly, such claims contemplate a practical application that yields a useful, concrete and tangible result, i.e., classification of fraud detection data, credit evaluation data, gene expression data, medical diagnostic data or medical prognostic data.

In support of the rejection of these claims under section 101, the Examiner stated that the limits of these claims are merely limits to "a 'technological environment,' i.e., field of use." The Examiner quoted *Diamond v. Diehr*, in which the Supreme Court states "[a] mathematical formula as such is not accorded the protection of our patent laws, and this principle cannot be circumvented by attempting to limit the use of the formula to a particular technological environment."[65] Diehr goes on to state, however, that "[o]n the other hand, when a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were

[65] *Diamond v. Diehr*, 450 U.S. 175, 185 (1981).

designed to protect ...then the claim satisfies the requirements of §101."[66]

Appellant is not merely limiting the use of a mathematical algorithm to a particular field of use as asserted by the Examiner. Rather, the claims directly recite the type of data classified using the SVM classifier. In other words, the claims do not vaguely refer to the field of fraud detection or gene expression. On the contrary, the pertinent claims recite a support vector machine or application of support vector machine classifier to classify data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis, or data relating to multiple myeloma. Hence, the Examiner's dismissal of such claims as merely providing field of use limitations is improper.

Additionally, the specificity with which Appellant's claims specify the nature of the data is at least as specific as the allowed claims in the patents listed above. For example, the claims of the '618 patent, to the extent they specify a particular type of data, specify only data relating to physical measurements. Data relating to physical measurements are no more a specific type of data than data relating to fraud detection, credit evaluation, gene expression, or the like. Likewise, the claims of the '715 patent, to the extent they specify a particular type of data, specify only biological data, which is also no more specific than the specific types of data listed in Appellant's claims. In fact, biological data may even be less specific than the specific type of data listed in Appellant's claims 47, 50 and 53.

For at least these reasons, claims 46, 47, 49, 50, 52 and 53 provide a real-world practical application, and therefore, Appellant respectfully requests withdrawal of the rejection of these claims under section 101.

Claims 55-57

With reference to claim 55, the claim recites a support vector machine classification system comprising a data storage medium storing input data for classification, a support vector machine classifier that classifies the input data into a first set of data and a second set of data based on a set of input features and a selection module that produces a reduced set of input features for the support vector machine classifier based on a minimization of an exterior penalty function of a dual of a linear programming formulation of the linear support vector machine

[66] Id.

classifier for a finite value of a penalty parameter. As with claim 1 above, the claims provide a practical application without the need to specify the particular nature of data. In particular, the claims provide a real-world practical application of selecting a reduced set of input data for the SVM classifier. Claims 56 and 57 set forth similar requirements pertaining to the real-world result of SVM data classification. For at least these reasons, claims 55-57 provide a real-world practical application, and therefore, Appellant respectfully requests withdrawal of the rejection of these claims under section 101.

Claim Rejection Under 35 U.S.C. § 112

In the final Office Action, the Examiner rejected claims 1-57 under 35 U.S.C. § 112, first paragraph. The Examiner indicated that such a rejection is required in view of the section § 101 rejection. Without addressing this contention in detail, Appellant respectfully submits that the claimed invention satisfies the subject matter eligibility requirements of section § 101, for the reasons expressed above. Therefore, it follows that the rejection under 35 U.S.C. § 112, first paragraph, should be withdrawn, as the disclosure clearly is sufficient to enable one skilled in the art to make and use the invention for a practical application, e.g., selection of input for use in data classification, without undue experimentation. Moreover, the disclosure adequately describes every feature set forth in the claims.

Claim Rejection Under 35 U.S.C. § 102

In the Final Office Action, the Examiner rejected claims 1-57 under 35 U.S.C. § 102(b) as being anticipated by "Finite Newton Method for Lagrangian Support Vector Machine Classification" by Fung et al., Data Mining Institute Report, 02-01, February 2002 (Fung). Appellant respectfully traverses the rejection. Fung fails to disclose the claimed invention, as required by 35 U.S.C. § 102(b), and provides no teaching that would have suggested the desirability of modification to include such features. The discussion below addresses the rejections in terms of the limitations set forth in the various claims.

Claim 1, 4-9, 12, 16, 19-24, 27, 31, 34-39, 42 and 47-54

Fung does not disclose or suggest defining a linear programming formulation of a support vector machine classifier, solving an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier, and selecting an input set for the support vector machine classifier based on the solution, as set forth in independent claims 1. Fung also does not suggest a computer-readable medium storing instructions to cause a processor to perform such functions, as recited in claims 31.

Fung also lacks any teaching that would have suggested a classification system comprising a processor that applies a linear programming formulation of a support vector machine classifier to classify data based on an input set, and an input module that generates the input set based on a solution of an exterior penalty function of a dual of the linear programming formulation, as defined by claim 16.

As repeatedly pointed out by Appellant, Fung does not disclose the use of a linear programming formulation of a support vector machine classifier. On the contrary, as described by Appellant at paragraph [0028] of the Specification, Fung describes a quadratic programming formulation of a support vector machine. The quadratic programming formulation of the support vector machine in Fung is much more complex than that of the Appellant's linear programming formulation. In the vicinity of page 3, paragraph 2, line 9, Fung reads as follows:

> with ones or minus ones along its diagonal. For this problem, the standard support vector machine with a linear kernel AA' [27, 3] is given by the following quadratic program for some $\nu > 0$:
>
> $$\begin{array}{rll} \min\limits_{(w,\gamma,y)\in R^{n+1+m}} & \nu e'y + \frac{1}{2}w'w & \\ \text{s.t.} & D(Aw - e\gamma) + y \geq e & \\ & y \geq 0. & \end{array} \qquad (2)$$

In the above passage, Fung clearly refers to a quadratic program for a support vector machine. A quadratic programming formulation is nonlinear. A quadratic programming formulation, unlike a linear programming formulation as claimed, does not generate sparse solutions and hence does not suppress input features.[67] This characteristic of a nonlinear, quadratic programming

[67] Appellant's specification, ¶ [0028].

formulation contrasts with the very significant feature suppression property possible with a linear programming formulation as claimed.[68]

Despite Appellant's previous attempt to clarify the content of the Fung reference, the Examiner again relied on the very same passage in Fung. In the Examiner's reply to Appellant's arguments in the Final Office Action, the Examiner restated the language from Appellant's claims and again pointed to page 3, paragraph 2, of Fung. The Examiner also cited page 4, lines 1-3 of Fung, which further illustrates that equation (2) is a quadratic programming formulation, i.e., nonlinear. In particular, the referenced portion of Fung states, "[t]he quadratic term in (2), which is twice the reciprocal of the square of the 2-norm distance $\frac{2}{\|w\|}$ between the two bounding planes of (3) in the n-dimensional space of $w \in R^n$ for a fixed γ, maximizes that distance, often called the 'margin'." Thus, Fung specifically states that there is a quadratic term within the programming formulation of equation (2), thus making the programming formulation nonlinear. The Examiner also cited page 9, ¶ [0037] of Appellant's own specification, which states "In a linear programming formulation of the standard SVM in equation (2), the term $\frac{1}{2}w'w$ is replaced by $\|w\|_1$, which is twice the reciprocal of the ∞-norm distance between the bounding planes of equation (3)." This paragraph describes the fundamental changes made to the nonlinear (quadratic) programming formulation of equation (2) to transform it to a linear programming formulation. In other words, ¶ [0037] describes how Appellant replaces the quadratic term of equation (2), i.e., $\frac{1}{2}w'w$, with a linear term, i.e., $\|w\|_1$, thus making equation (2) a linear programming formulation version of the standard SVM nonlinear equation. Clearly, paragraph [0037] is part of Appellant's own disclosure, and does not reside within the Fung reference. Accordingly, it cannot be relied upon as prior art. Nor does paragraph [0037] support the Examiner's position in any other way.

In addition to the shortcomings noted above, Fung also fails to teach or suggest solving an exterior penalty function of a dual of the linear programming formulation, as further required by Appellant's claims 1, 16 and 31. In support of the rejection the Examiner referenced Fung at

[68] Id.

page 5, equation (10) and characterized equation (10) as describing an exterior penalty function of the dual of the linear programming formulation. Appellant respectfully submits that the Examiner has mischaracterized equation (10). First, for the reasons set forth above, Fung fails to disclose a linear programming formulation, and therefore could not possibly disclose an exterior penalty function of the dual of such a linear programming formulation.

Secondly, as stated on page 5 of Fung, equation (10) is the dual of the nonlinear (quadratic) formulation problem of equation (7) using the defined matrices given in equations (9). Because equation (10) is the dual of the nonlinear programming formulation, as indicated in the Fung reference, it cannot be the exterior penalty function of the dual as asserted by the Examiner. In fact, equation (10) of Fung is not an exterior penalty function whatsoever, but is merely a quadratic dual problem that bears no relation to the Appelant's dual linear program.

In light of Appellant's clarification of Fung, it is unclear how the Examiner could continue to rely on Fung as an anticipatory reference with respect to Appellant's claims 1, 4-9, 12, 16, 19-24, 27, 31, 34-39, 42 and 47-54. The fundamental differences identified above make clear that Fung does not disclose or suggest the invention defined by Appellant's claims. Therefore, Appellant respectfully requests withdrawal of the rejection under section 102 in view of Fung.

Claim 2, 10, 11, 17, 25, 26, 32, 40 and 41

Additionally, Fung fails to disclose the limitations recited in claims 2, 10, 11, 17, 25, 26, 32, 40 and 41. For example, Fung fails to disclose minimizing the exterior penalty function for a finite value of a penalty parameter, as recited in claims 2, 17 and 32. Fung also fails to disclose applying a Newton-based algorithm to solve the exterior penalty function, as required by Appellant's claims 10, 25 and 40. Moreover, Fung fails to disclose applying one or more linear constraints to the solution of the exterior penalty function, as recited in Appellant's claims 11, 26 and 41. As described above in reference to Appellants' claims 1, 16 and 31, Fung fails to disclose defining a linear programming formulation and solving an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier, and therefore could not have possibly disclosed the requirements of claims 2, 10, 11, 17, 25, 26, 32, 40 and 41 which are further requirements for the solving of the exterior penalty

function. In view of the above differences, the rejection of claims 2, 17 and 32 is improper and should be reversed.

Claim 3, 18 and 33

Fung fails to disclose the linear programming formulation comprising a 1-norm linear programming formulation, as recited in claims 3, 18 and 33. Claims 3, 18 and 33 are dependent from Appellants' independent claim 1 and 31, respectively. As described above in reference to Appellants' claims 1, 16 and 31, Fung fails to disclose defining a linear programming formulation at all and thus could not possibly contemplate forming a 1-norm linear programming formulation as required by Appellant's dependent claims 3, 18 and 33

Claims 13-15, 28-30 and 43-45

Fung fails to disclose selecting a subset of input features that is less than approximately one percent of the larger set of input features, as recited in Appellant's dependent claims 13, 28 and 43. Additionally, Fung fails to disclose selecting a subset of input features includes less than approximately .1 percent of the larger set of input features, as required by Appellant's claims 14, 29 and 44. Moreover, Fung fails to disclose the larger set of input features includes more than 20,000 input features, and the subset of input features includes less than ten input features, as required by Appellant's claims 15, 30 and 45.

In support of the rejection of claims 13-15, 28-30 and 43-45, the Examiner referenced page 14, ¶ 5 of the Fung reference. The referenced section describes comparison of the Newton SVM algorithm on a dataset in terms of speed and generalization ability. The Fung reference, however, fails to disclose selecting a subset of input features from a larger set of input features that satisfy the requirements of claims 13-15, 28-30 and 43-45. As illustrated in TABLE 2 on page 22 of Appellant's specification, the NSVM algorithm described in Fung depends on all the original input features. Moreover, to the extent that the NSVM algorithm described in Fung depends on only a subset of the input features (e.g., see TABLE 1, where the NSVM reduces the number of features from 28032 to 6554), the subset of input features and the original set of input features are surely not within the ranges specified in claims 13-15, 28-30 and 43-45.

In view of the above differences and the differences described with respect to claims 1, 16 and 31, the rejection of claims 13-15, 28-30 and 43-45 is improper and should be reversed.

Claim 55 and 57

In addition, Fung fails to disclose or suggest a support vector machine classification system comprising a data storage medium storing input data for classification, a support vector machine classifier that classifies the input data into a first set of data and a second set of data based on a set of input features, and a selection module that produces a reduced set of input features for the support vector machine classifier based on a minimization of an exterior penalty function of a dual of a linear programming formulation of the linear support vector machine classifier for a finite value of a penalty parameter, as set forth in claims 55-57.

As described above with respect to independent claims 1, 16 and 31, does not disclose the use of a linear programming formulation of a support vector machine classifier, but instead of a nonlinear programming formulation (i.e., quadratic programming formulation). Moreover, as further described with respect to claims 1, 16, and 31, Fung fails to disclose selecting a reduced set of input features based on a minimization of an exterior penalty function of a dual of the linear programming formulation. For at least these reasons, Fung fails to disclose the requirements of Appellant's claims 55 and 57 and should be reversed.

Claim 56

Fung also fails to disclose a support vector machine classification system that includes dual generator that generates the dual of a linear programming formulation of the linear support vector machine classifier, an exterior penalty function solver that minimizes the exterior penalty function of the dual and a feature generator that generates the reduced set of input features for the support vector machine classifier. As described above with respect to claim 55, Fung fails to disclose solving an exterior penalty function, and therefore could not have possibly disclosed an exterior penalty function solver that minimizes the exterior penalty function of the dual. For at least these reasons, the rejection of claim 56 is improper and should be reversed.

In summary, Fung fails to disclose each and every limitation set forth in claims 1-57. For at least these reasons, the Fung reference cannot support a prima facie case of anticipation of

Appellants' claims 1-57 under 35 U.S.C. § 102(b). Withdrawal of this rejection is respectfully requested.

CONCLUSION

The Examiner has failed to meet the burden of establishing a prima facie case of anticipation with respect to claims 1-57. In view of Appellants' arguments, the final rejection of Appellants' claims is improper and should be reversed. Reversal of all pending rejections and allowance of all pending claims is respectfully requested.

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APPENDIX A: THE CLAIMS ON APPEAL

Claim 1 (Original) A method comprising:

defining a linear programming formulation of a support vector machine classifier;

solving an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier; and

selecting an input set for the support vector machine classifier based on the solution.

Claim 2 (Original) The method of claim 1, further comprising minimizing the exterior penalty function for a finite value of a penalty parameter.

Claim 3 (Original) The method of claim 1, wherein the linear programming formulation is a 1-norm linear programming formulation.

Claim 4 (Original) The method of claim 1, wherein the solution is a least 2-norm solution.

Claim 5 (Original) The method of claim 1, wherein the support vector machine classifier is a linear support vector machine classifier, and selecting an input set includes selecting a set of input features of the linear support vector machine classifier.

Claim 6 (Original) The method of claim 1, wherein the support vector machine classifier is a nonlinear support vector machine classifier, and selecting an input set includes selecting a set of kernel functions for the nonlinear support vector machine classifier.

Claim 7 (Previously Presented) The method of claim 1, further comprising:

calculating a separating surface based on the input set and the support vector machine classifier; and

classifying data using the separating surface.

Claim 8 (Original) The method of claim 7, further comprising classifying the data into two sets of data using the separating surface.

Claim 9 (Original) The method of claim 7, wherein the separating surface is one of an n-dimensional hyperplane or a nonlinear surface.

Claim 10 (Original) The method of claim 1, further comprising applying a Newton-based algorithm to solve the exterior penalty function.

Claim 11 (Original) The method of claim 1, further comprising applying one or more linear constraints to the solution of the exterior penalty function.

Claim 12 (Original) The method of claim 1, wherein selecting an input set includes selecting a subset of input features from a larger set of input features that is substantially larger than the subset of input features.

Claim 13 (Original) The method of claim 12, wherein the subset of input features includes less than approximately one percent of the larger set of input features.

Claim 14 (Original) The method of claim 12, wherein the subset of input features includes less than approximately .1 percent of the larger set of input features.

Claim 15 (Original) The method of claim 12, wherein the larger set of input features includes more than 20,000 input features, and the subset of input features includes less than ten input features.

Claim 16 (Original) A classification system comprising:

a processor that applies a linear programming formulation of a support vector machine classifier to classify data based on an input set; and

an input module that generates the input set based on a solution of an exterior penalty function of a dual of the linear programming formulation.

Claim 17 (Original) The system of claim 16, wherein the input module generates the input set based on a minimization of the exterior penalty function for a finite value of a penalty parameter.

Claim 18 (Original) The system of claim 16, wherein the linear programming formulation is a 1-norm linear programming formulation.

Claim 19 (Original) The system of claim 16, wherein the solution is a least 2-norm solution.

Claim 20 (Original) The system of claim 16, wherein the support vector machine classifier is a linear support vector machine classifier, and the input set includes a set of input features of the linear support vector machine classifier.

Claim 21 (Original) The system of claim 16, wherein the support vector machine classifier is a nonlinear support vector machine classifier, and the input set includes a set of kernel functions for the nonlinear support vector machine classifier.

Claim 22 (Previously Presented) The system of claim 16, wherein the processor calculates a separating surface based on the input set and the support vector machine classifier, and classifies data using the separating surface.

Claim 23 (Original) The system of claim 22, wherein the processor classifies the data into two sets of data using the separating surface.

Claim 24 (Original) The system of claim 22, wherein the separating surface is one of an n-dimensional hyperplane or a nonlinear surface.

Claim 25 (Original) The system of claim 16, wherein the input module applies a Newton-based algorithm to solve the exterior penalty function.

Claim 26 (Original) The system of claim 16, wherein the solution to the exterior penalty function is subject to one or more linear constraints.

Claim 27 (Original) The system of claim 16, wherein the input set is a subset of input features selected from a larger set of input features that is substantially larger than the subset of input features.

Claim 28 (Original) The system of claim 27, wherein the subset of input features includes less than approximately one percent of the larger set of input features.

Claim 29 (Original) The system of claim 27, wherein the subset of input features includes less than approximately .1 percent of the larger set of input features.

Claim 30 (Original) The system of claim 27, wherein the larger set of input features includes more than 20,000 input features, and the subset of input features includes less than ten input features.

Claim 31 (Original) A computer-readable medium comprising instructions to cause a processor to:

define a linear programming formulation of a support vector machine classifier;

solve an exterior penalty function of a dual of the linear programming formulation to produce a solution to the support vector machine classifier; and

select an input set for the support vector machine classifier based on the solution.

Claim 32 (Original) The computer-readable medium of claim 31, further comprising instructions to cause a processor to minimize the exterior penalty function for a finite value of a penalty parameter.

Claim 33 (Original) The computer-readable medium of claim 31, wherein the linear programming formulation is a 1-norm linear programming formulation.

Claim 34 (Original) The computer-readable medium of claim 31, wherein the solution is a least 2-norm solution.

Claim 35 (Original) The computer-readable medium of claim 31, wherein the support vector machine classifier is a nonlinear support vector machine classifier, and the input set includes a set of input features for the linear support vector machine classifier.

Claim 36 (Original) The computer-readable medium of claim 31, wherein the support vector machine classifier is a nonlinear support vector machine classifier, and the input set includes a set of kernel functions for the nonlinear support vector machine classifier.

Claim 37 (Previously Presented) The computer-readable medium of claim 31, further comprising instructions to cause a processor to:

calculate a separating surface based on the input set and the support vector machine classifier; and

classify data using the separating surface.

Claim 38 (Original) The computer-readable medium of claim 37, further comprising instructions to cause a processor to classify the data into two sets of data using the separating surface.

Claim 39 (Original) The computer-readable medium of claim 37, wherein the separating surface is one of an n-dimensional hyperplane and a nonlinear surface.

Claim 40 (Original) The computer-readable medium of claim 31, further comprising instructions to cause a processor to apply a Newton-based algorithm to solve the exterior penalty function.

Claim 41 (Original) The computer-readable medium of claim 31, further comprising instructions to cause a processor to apply one or more linear constraints to the solution of the exterior penalty function.

Claim 42 (Original) The computer-readable medium of claim 31, further comprising instructions to cause a processor to select a subset of input features from a larger set of input features that is substantially larger than the subset of input features.

Claim 43 (Original) The computer-readable medium of claim 42, wherein the subset of input features includes less than approximately one percent of the larger set of input features.

Claim 44 (Original) The computer-readable medium of claim 42, wherein the subset of input features includes less than approximately .1 percent of the larger set of input features.

Claim 45 (Original) The computer-readable medium of claim 42, wherein the larger set of input features includes more than 20,000 input features, and the subset of input features includes less than ten input features.

Claim 46 (Previously Presented) The method of claim 1, further comprising applying the support vector machine classifier to classify data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis.

Claim 47 (Previously Presented) The method of claim 1, further comprising applying the support vector machine classifier to classify data relating to multiple myeloma.

Claim 48 (Previously Presented) The method of claim 1, further comprising applying the support vector machine classifier to classify data relating to absolute call measurements for multiple myeloma.

Claim 49 (Previously Presented) The system of claim 16, wherein the processor applies the support vector machine classifier to classify data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis.

Claim 50 (Previously Presented) The system of claim 16, wherein the processor applies the support vector machine classifier to classify data relating to multiple myeloma.

Claim 51 (Previously Presented) The method of claim 16, wherein the processor applies the support vector machine classifier to classify data relating to absolute call measurements for multiple myeloma.

Claim 52 (Previously Presented) The computer-readable medium of claim 31, wherein the instructions cause the processor to apply the support vector machine classifier to classify data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis.

Claim 53 (Previously Presented) The computer-readable medium of claim 31, wherein the instructions cause the processor to apply the support vector machine classifier to classify data relating to multiple myeloma.

Claim 54 (Previously Presented) The computer-readable medium of claim 31, wherein the instructions cause the processor to apply the support vector machine classifier to classify data relating to absolute call measurements for multiple myeloma.

Claim 55 (Previously Presented) A support vector machine classification system comprising:

a data storage medium storing input data for classification;

a support vector machine classifier that classifies the input data into a first set of data and a second set of data based on a set of input features; and

a selection module that produces a reduced set of input features for the support vector machine classifier based on a minimization of an exterior penalty function of a dual of a linear programming formulation of the linear support vector machine classifier for a finite value of a penalty parameter.

Claim 56 (Previously Presented) The system of claim 55, wherein the selection module includes:

a dual generator that generates the dual of a linear programming formulation of the linear support vector machine classifier; and

an exterior penalty function solver that minimizes the exterior penalty function of the dual; and

a feature generator that generates the reduced set of input features for the support vector machine classifier.

Claim 57 (Previously Presented) The system of claim 55, wherein the support vector machine classifier classifies data relating to one of fraud detection, credit evaluation, gene expression, intrusion detection, medical diagnosis or medical prognosis.

APPENDIX B: EVIDENCE APPENDIX

NONE

APPENDIX C: RELATED PROCEEDING APPENDIX

NONE